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ABSTRACT

The San Francisco Math Leadership Project is an attempt to re-educate elementary teachers, many of whom do not consider mathematics their favorite subject and have limited mathematics backgrounds. The task is to increase the mathematics knowledge of these teachers and build their confidence in their own ability to do mathematics and to teach it. Leadership development begins with a 4-week summer institute and continues with workshops presented by participants at their school sites. In this paper, discussions include background of former participants, goals of the project, and leadership activities of former participants. Three graphs and three tables are included, as well as survey forms and responses. (DC)

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MAKING MATH LEADERS:
THE SAN FRANCISCO MATH LEADERSHIP PROJECT
1984 - 1988

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Currently in its fifth year, the San Francisco Math Leadership Project is one of the fifteen California Mathematics Projects funded by the State of California. Each project is connected with either the University of California (UC) or the California State University (CSU) system of higher education. Several educational agencies work together at the state level to implement this project. This collaboration is exemplified by the very active fourteen member Advisory Board representing the following: California Postsecondary Education Commission, University of California, California State University, California Labor Federation AFL-CIO, California Community Colleges, Superintendent of Public Instruction, Association of Independent Colleges and Universities, and the State Department of Education. At the local site level, the school district administrators and school principals play a major role in extending the project by utilizing the talents of the teacher leaders the project has developed. It is this collaboration among the teachers, principals, school district personnel and the university that has contributed to the success and impact of this project during the past five years. The San Francisco project differs from the other California Math Projects in two distinct ways: it is one of only two projects that work with teachers of grades K-8, rather than K-12, 9-12, or 7-12; and it is the only project which concentrates on teachers from a single school district.

To put a math project in perspective, I'd like to mention current events concerning mathematics education in California. Two major documents have recently been published by the California State Department of Education: The Mathematics Framework (1985) and the Mathematics Model Curriculum Guide (1987). At the national level, the National Council of Teachers of Mathematics (NCTM) will be soon disseminating its newest document: Curriculum and Evaluation Standards for School Mathematics (1989). In addition, in California, this is the first year that schools are using the newly adopted textbooks. As you

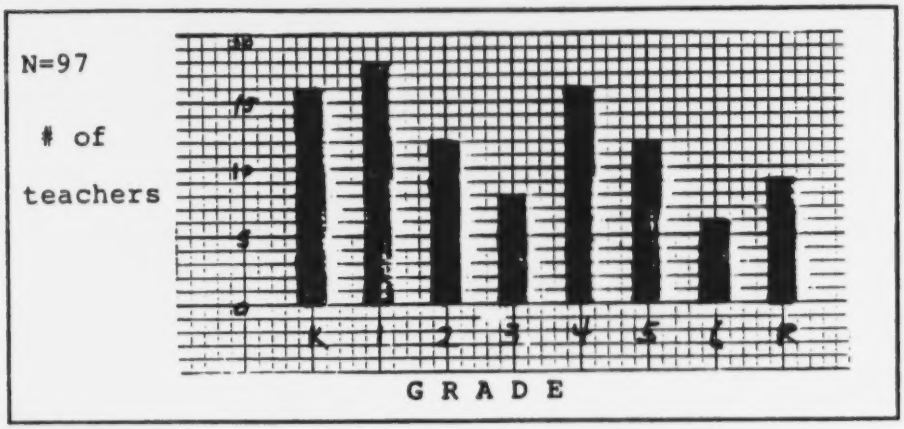
may recall, the textbook adoption was delayed for a full year because there was not a close enough match between the textbooks and the framework, thus forcing the publishers to make some changes.

The following highlights from the Mathematics Framework exemplify the changes in math teaching promoted by math educators both in California and at the national level.

> "By brainstorming, exploring various approaches, and solving problems **cooperatively,** students can gain confidence in their individual abilities..."
>
> "**Manipulative materials** can be used profitably to introduce concepts, even at the high school level..."
>
> "Allow for the fact that more than one strategy may be needed to solve a given problem and that problems may require **original approaches**..."
>
> "Before the end of the sixth grade, students should have **calculators** continually available for use -- in class, on homework assignments, and **on tests**..."
>
> "**Adequate time for problem solving** must be provided because the students, not the teacher, must do the thinking, make decisions, and find successful means to solve the problems..."

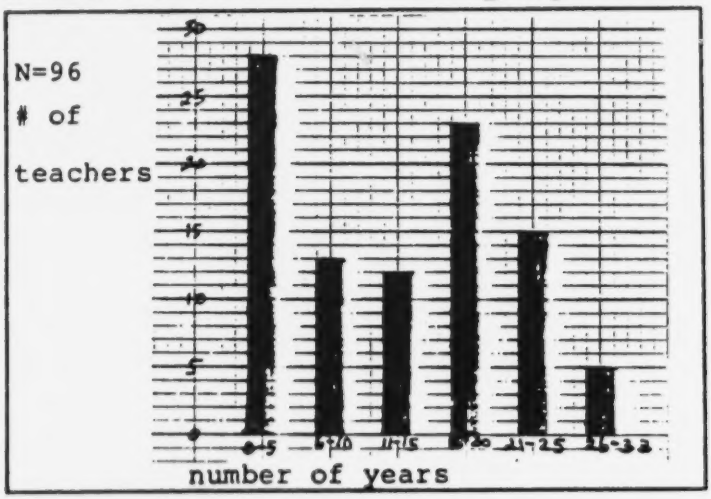
It is an enormous undertaking to attempt to reeducate elementary teachers, many of whom do not consider math their favorite subject. Some of them perhaps entered the teaching profession precisely because there were no college math requirements; many have not taken a math course since high school. Following is some background information on the ninety-seven teachers who participated during the first four years of this project., 1984-1987. The grade level they teach, the number of years of teaching experience, their mathematics background, and their attitude toward math are included.

Grade Level Taught by Participants (1984-1987)



During the past four years we have had fifty-six teachers of the primary grades, (K-3), thirty-four teachers of the intermediate grades (4-6) and 9 teachers with resource or other teaching positions. We continue to attempt to attract more teachers from the intermediate and middle school grades.

Number of Years of Teaching Experience

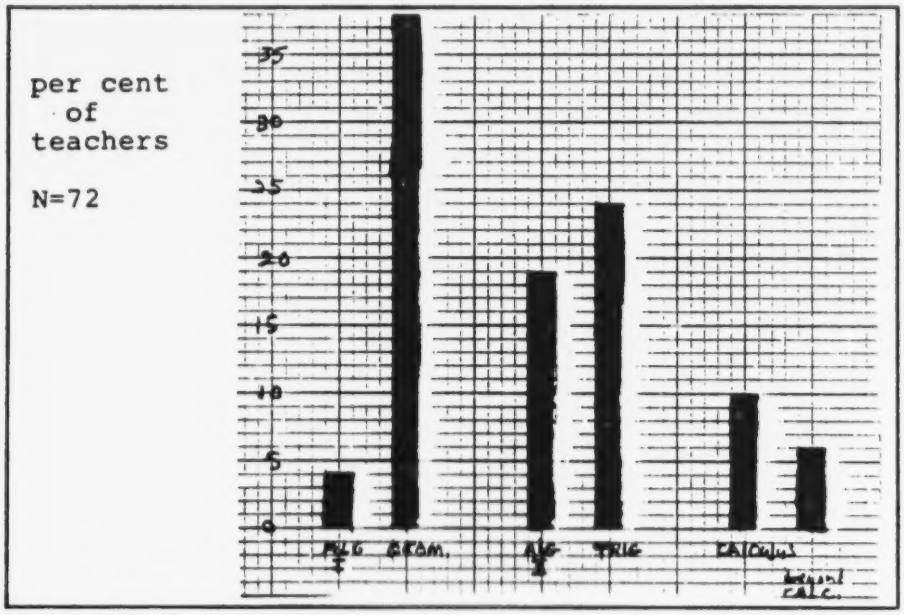


The range extends from first year teachers (6) to 33 years (2) of teaching experience with 13.2 as the average number of years taught. It is also interesting to note that 55% of our teachers had taught for less than 20 years and 45% had taught for more than 20 years at the time of enrolling in this project.

Math Background of Participants

For the three years, 1985, 1986, and 1987, data were collected on the math courses taken (N=72). Not one of ninety-seven participants had majored in math in college and only one had a mathematics minor.

What is the Highest Level of Math You Have Completed?



The limited math backgrounds of these teachers plus the fact that these few math courses were taken by many more than 20 years ago contribute to their own weaknesses in the area of mathematics.

Teachers' responses to the following questions provided more information about their attitudes toward math. A questionnaire was completed prior to the summer institute. This information was collected from the fifty-four '86 and '87 participants.

WHEN I WAS A HIGH SCHOOL STUDENT:	**Not at all Descriptive 1**	**2**	**Somewhat 3**	**4**	**Very Descriptive 5**
a. Mathematics was one of my favorite subjects (X=2.4)					
b. Teachers encouraged me to continue my math education (X=1.7)					
c. I avoided mathematics whenever possible (X=2.5)					
d. Most of my math teachers were very good (X=2.7)					
e. Mathematics was generally easy for me (X=2.6)					

It is interesting to note that 62% of the responses to item (b) (Teachers encouraged me to continue my math education) were 1 (not at all descriptive). Except for item (d) where many of the responses were 2 or 3, the responses were for the most part either high or low, showing the participants' strong opinions on these items.

A math content pre-test is given on the first day of each summer institute. Of the 24 items on this math test, more than 30% of the 97 participants have missed the following items. These basic math concepts are an important part of the math curriculum for the elementary grades.

Problems Missed by More than 30% of the Participants

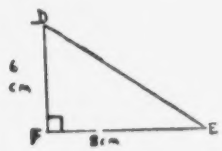
THE FOLLOWING ARE THE NUMBERS OF STUDENTS IN NINE ROOMS IN THE JACKSON ELEMENTARY SCHOOL.

27 29 35 12 15 29 19 24 30

Compute the MEAN
Compute the MEDIAN
Compute the MODE

(55% missed Mean; 62% missed Median; 67% missed Mode)

FIND THE LENGTH OF THE SIDE DE OF TRIANGLE DEF.



(Missed by 66%)

IF YOU WERE TO ROLL A DIE, WHAT IS THE PROBABILITY THAT THE ROLL WILL RESULT IN A SIX?.....A THREE OR FIVE?

(Missed by 63%)

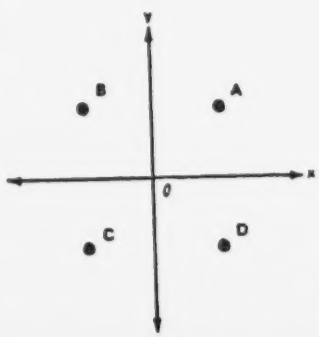
SUE SAVES 12% OF HER EARNINGS. SHE SAVED $18.00 WHAT WERE HER EARNINGS?

(Missed by 44%)

FIND THE AREA OF THE TRIANGLE.

(Missed by 32%)

WHICH POINT COULD HAVE THE COORDINATES (3,-3) ?



(Missed by 30%)

It is also interesting to note that 24% were not able to recognize the formula for the area of a square, and 19% were not able to convert a decimal to a percent.

What is the formula for the area, A, of a square with sides of length, ℓ?

- A = 4 x ℓ
- A = 2 x ℓ
- A = 2ℓ + 2ℓ
- A = ℓ x ℓ

0.05 =

- 5%
- 50%
- .5%
- .05%

On the last day of the summer institute a post-test is given. The results of the post-test compared to the pre-test data are presented below.

Results of Math Test

Project Year	Pre-Test	Post-Test	Significance
1984 (n=24)	$\bar{X}$ = 19.5[1]	$\bar{X}$ = 20.5	t = 1.199
1985 (n=19)	$\bar{X}$ = 15.9	$\bar{X}$ = 17.7	t = 1.083
1986 (n=25)	$\bar{X}$ = 16.9	$\bar{X}$ = 19.0	t = 1.371*
1987 (n=28)	$\bar{X}$ = 14.5	$\bar{X}$ = 17.5	t = 3.047**
Combined n = 96	$\bar{X}$ = 16.6	$\bar{X}$ = 18.7	t = 3.044*

[1]Mean score for number correct based on a total of 24 questions.

*$p < .10$

**$p < .01$

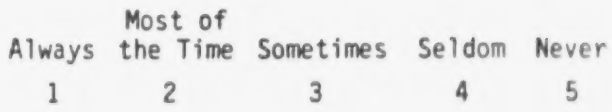
As can be seen in this table, it was possible for the teachers to perform better on the math test following even the brief summer institute. The pre- and post-test questions were drawn from the same domains (e.g. algebra, geometry, statistics, etc.) but were different questions to control for a practice effect. You will note that the most significant change occurred among the 1987 group. This is particularly noteworthy given that their scores were the lowest , on average, of the first four groups of teachers. It is also noteworthy that the first group (1984) had the highest mean scores on both the pre- and post-tests suggesting that the first group to volunteer for this program were those who had less difficulty with math, but that with time, the project has attracted those teachers who feel less skilled in this area, and can therefore benefit the most from the training and support provided.

There is a second part to the Math Test that involves a group problem solving exercise followed by a series of questions that teachers are asked to respond to on a Likert-type scale. The first set of questions deals with teachers' attitudes toward math in general and toward the teaching of math. The second set of questions deals with the teachers' report of their experience in doing the problem solving exercise. The results from the participants in the first four years of the project are summarized on the next page.

Ideally, mean scores should decline on the post-test (indicating more positive attitudes) in response to the statements regarding liking math, having good math teachers, and liking to teach math. Conversely, mean scores should increase (again indicating more positive attitudes) in response to the statements about feeling insecure when attempting math, and finding math difficult. As can be seen in the table, there were changes in the expected direction in response to each of the statements, with the most dramatic change in response

Results of Attitude Survey (n=96)

x = Pre-Test
+ = Post Test



I like math. It's interesting, fun, and it makes sense.

(Pre $\bar{X}$=2.1; Post $\bar{X}$=1.9)

I feel a sense of insecurity when attempting math.

(Pre $\bar{X}$=2.9; Post $\bar{X}$=3.3)

I have had good math teachers.

(Pre $\bar{X}$=3.1; Post $\bar{X}$=3.2)

I like to teach math and I feel at ease teaching it.

(Pre $\bar{X}$=2.2; Post $\bar{X}$=2.0)

Math is difficult for me to learn.

(Pre $\bar{X}$=3.1; Post $\bar{X}$=3.2)

I enjoyed trying these problems.

(Pre $\bar{X}$=4.4; Post $\bar{X}$=4.6)

I felt frustrated because I had no idea how to approach them.

(Pre $\bar{X}$=2.0; Post $\bar{X}$=1.6)

I do not know how to solve these because I don't know the formulas.

(Pre $\bar{X}$=1.7; Post $\bar{X}$=1.5)

I think these problems are important, but school time should be spent in more effective ways.

(Pre $\bar{X}$=1.4; Post $\bar{X}$=1.3)

to the statement, "I feel a sense of insecurity when attempting math." On the pre-test, only 15% of the teachers indicated that this was "seldom" of "never" the case, whereas on the post-test, the respondents in these categories had increased to 36%. Similarly, on the pre-test 14% of the teachers responded that hey felt insecure "always" or "most of the time;" but on the post-test none of the teachers responded "always," and only 6% responded, "most of the time."

With regard to teachers' responses to the problem solving activities, we were expecting to see stronger agreement on the post-test with the statements "I enjoyed trying these problems," and stronger disagreement with the statements relating to frustration, not knowing how to solve the problems, and the view that problem solving activities should not be given too much time in school. Again, all the changes were in the expected direction, with the strongest change occuring in response to the statement, " I felt frustrated because I had no idea how to approach them [the problems]." While the data presented in this table are summarized for the entire group, we also analyzed the data on a year-by-year basis and the effects described above are consistent across each of the four groups of participants.

Our task, as you can see, is twofold: to increase the mathematical knowledge of these teachers, and then build their confidence in their own ability to do mathematics and to teach it. We must also give them the opportunity to enjoy learning math so they can bring this excitement, creativity, and confidence to their students.

There are many aspects of this project that I would like to share with you. But I will limit myself to the one most appropriate for this particular conference. I will describe the leadership development component, as it is this

model that can possibly be transferred to other subject areas. First, let's look at the goals of the project:

1. To provide teams of urban classroom teachers with a year long program that will improve their own mathematical / problem-solving skills, build their confidence, and increase their effectiveness as classroom teachers.

2. To provide the participants with ongoing training in two ways: through classroom visitation at their school sites; and through monthly support meetings.

3. To facilitate an outreach to classroom teachers by preparing the participants to share their expertise with colleagues in their schools and district; by providing assistance in the development of workshops; and by funding basic materials for each participating school.

4. To enlarge the existing nucleus of mathematics leaders in the Bay Area by including these participants as active contributors to local conferences, to their district inservice programs, and primarily to their own schools.

This model for developing math leadership within a school district has several stages of development. The initial phase is the intensive 4-week summer institute attended by pairs of teachers which includes expanding the teachers' knowledge of math content and teaching strategies and beginning leadership preparation. This is followed by a year-long support program which includes monthly meetings and classroom visits. The next level of leadership is supported by the district by recognizing the leadership abilities of those who have been reeducated and by giving them recognition and opportunities to use their skills within the district. This three part - development / inservice / outreach - team approach plan was designed in order to encourage women and minority teachers to overcome their reluctance to assume leadership in mathematics education.

We attempt to meet these goals with the following basic structure of the project. The intensive 4-week summer institute meets for 4 whole days each week. The participants are surrounded by mathematics, not just arithmetic. They are paid stipends and receive credit and materials for their classrooms. During the year there are monthly meetings, sometimes held at the university, at other times at school sites. There are also classroom visits, demonstration lessons and workshop support. The teachers are required to present two workshops at their school sites and to attend a math conference. In addition there are ongoing grade-level planning groups led by past participants, often as part of their mentor teacher project. There is also a reunion for past participants each summer, separate from the regular institute.

With additional funding, we've been able to offer a 1-unit course during the year. We've offered two courses with a focus on using computers and one course with a focus on teaching algebra through the grades. This year we plan to offer a short course on probability concepts.

The leadership development actually begins during the summer institute. Most of the fourth week of the institute is devoted to practice workshops given by current participants. During the prior week a portion of each afternoon is devoted to having past participants help the new ones prepare for these workshops. Participants from the previous year are all invited to give presentations at the summer institute, and some past participants are invited back as special guests to speak on particular topics that they've developed during the past years.

We give preference to pairs of teachers from the same school. They then return to their schools and we have in fact provided the principals with 'math experts.' School site workshops have been extremely well received, and leadership potential of project teachers has been tapped. We've started telling

the teachers that they're making a lifetime commitment when they join the project. Many past participants continue to attend our monthly meetings and the district does support us by paying participants, current and past, for presenting workshops at their sites. They've also been asked to give workshops at schools not in the project.

Leadership opportunities must be provided for our past participants. Many of them have written and received grants to inservice their staffs and to buy more materials for their schools. Some teachers joined together to write (and received) a grant to present math faires at their schools. Two past participants recently wrote a book of ideas for Creative Math Homework. The district has also provided leadership opportunities for our teachers. Many were members of the Textbook Adoption Committee; others are on the Math Curriculum Development Committee. Project teachers were asked to do the inservice throughout the district on the newly adopted textbooks when it became clear that their workshops were superior to the publishing company's own consultants.

Several of our past participants are beginning to speak at local and statewide math conferences. One past participant was appointed to the statewide committee which will write the next new Math Framework. Another was just recently appointed as the district's new science coordinator.

And finally, several past participants have organized and formed a new organization for math teachers, called the San Francisco Math T.E.A.M. (Teachers of Elementary and Middle School). It has been in existence since September, is an affiliate of the California Math Council, Northern Section, and will sponsor its own math conference for San Francisco teachers next week.

The most important thing we've learned is that leadership development and the improvement of math teaching takes time. In the first three years of the

project we asked teachers, at the end of each academic year, to complete a self-evaluation of their own classroom in several key areas. Beginning with the 1987 Summer Institute group, we collected these data both prior to the Institute and at the end of their first year in the project. The data provided on the next page illustrate the results from the first pre-post assessment as well as data collected following one, two, three, and four years of participation in the project. You will note that there are fewer respondents in the longitudinal groups, nevertheless these data suggest that time is an important factor in achieving changes in classroom practices.

Looking first at the pre-post data from the 1987 group, we can see that highly significant changes occurred in two major areas -- increased versatility in the classroom and a strengthened learning component involving the use of manipulatives, activities that guarantee success, and multiple approaches to problem solving. Even more interesting, though, is the shift in self-evaluation that occurs with increased time in the project. You will note that the data for the combined group of all participants who responded after one year in the project is quite comparable to the 1987 post-test results, but that the self-evaluations continue to improve in subsequent years, and dramatically so by the end of the fourth year. We have to interpret these data with caution since there are so few respondents in the four year group and it is possible that only those most confident with the approaches have remained active. Nevertheless, these data certainly suggest that continued participation by teachers in project activities strengthens both their commitment to new teaching strategies as well as their comfort and confidence in implementing these ideas.

Self Evaluation of Own Classroom

	Pre	Post	Years Post-Institute			
	1987		1	2	3	4
I. CLASSROOM ATMOSPHERE	(n=25)		(n=69)	(n=29)	(n=11)	(n=3)
a. Atmosphere is positive & conducive to learning	2.2	2.1	1.4	1.6	1.6	1.3
b. Teacher has high expectations . .	1.8	1.8	1.8	1.5	1.3	1.0
c. Teacher is enthusiastic	1.8	1.7	1.7	1.5	1.1	1.0
d. Structure is confidence building.	2.2	2.2	2.1	1.6	1.2	1.3
e. Thinking is encouraged	2.1	2.0	1.7	1.4	1.2	1.3
f. Students are grouped in a variety of ways	2.5	2.1*	2.3	2.0	1.6	1.3
g. Children's work in evidence . . .	2.3	2.0	2.2	2.1	1.6	1.0
II. CLASSROOM VERSATILITY						
a. Varied strategies used to teach computing skills	3.0	2.2***	2.2	1.8	1.5	1.5
b. Equal time given to math/arithmetic	2.8	2.0**	2.0	1.8	1.5	1.5
c. Teacher provides for differences in students' learning styles	3.0	2.4**	2.4	2.1	1.6	1.0
d. Variety of math activities available for students' use . . .	2.9	2.1***	2.0	1.8	1.6	1.3
e. Overall content balanced	2.9	2.2**	2.1	1.6	1.4	1.3
III. PROBLEM SOLVING & THINKING SKILLS						
a. Emphasis on application in computing	3.0	2.4	2.5	2.1	1.8	1.0
b. Process as well as product articulated	2.8	2.4	2.2	1.7	1.3	1.3
c. Problems are formulated and analyzed	3.1	2.8	2.5	2.2	1.7	1.0
d. Students are encouraged to estimate and hypothesize	3.0	2.1***	2.1	2.1	1.6	1.7
e. Teacher has problem solving plan	3.4	3.3	2.7	2.2	2.0	1.7
f. Problems are used that have many right answers	3.4	3.0	2.8	2.5	2.1	2.0
IV. LEARNING COMPONENT						
a. Manipulative materials are used to reinforce concepts	2.5	1.7***	1.8	1.5	1.3	1.0
b. Concepts are developed from concrete to pictoral to symbolic	3.0	2.3**	2.2	2.0	1.9	1.0
c. Activities are used which guarantee success	2.8	2.0***	2.1	2.0	1.6	1.0
d. Many approaches and divergent thinking are encouraged	2.8	2.1**	2.1	1.8	1.5	1.0
e. Children are enjoying math sessions	2.3	1.6**	1.8	1.5	1.4	1.0
f. Children are being challenged . .	2.4	1.9	1.8	1.5	1.2	1.0

Scale: 1-2 = Excellent; 3 = Good; 4-5 = Needs More Focus
t-test significance levels: *$p < .05$; **$p < .01$; ***$p < .001$

Leadership development takes time and it also takes various forms. During the first four years, ninety-seven teachers representing thirty-three public and seven private schools have been project participants. All have given the two required workshops at their own school sites; many have continued to give workshops each year. All have attended at least one major math conference. For many, this is a first, and they continue to attend conferences each year. These teachers have all continued to grow in this area In this project, the classroom is the most important unit, followed by leadership at their own school sites. Then, some, but not all have become interested in working with other schools and expanding their workshop repertoire.

The district is not the only beneficiary of this work. The Department of Elementary Education has also gained. To me, the most important benefit is having model classrooms in which to place our students, both for their math observation/participation, and for their student teaching. Many teachers have returned to take courses, or to enter graduate programs, and many are involved in various other department projects. Several teachers were appointed adjunct professors and are currently team-teaching a seminar for student teachers. I repeat, leadership takes many forms, many of which we cannot project at the outset of an undertaking such as this. It is important, however, to recognize this leadership ability, to encourage it, and to reward it. I believe we have been extremely successful in developing math leadership at the elementary level in the San Francisco Unified School District.